The Influence of Music and Working Memory Load on Decision Making

Senior Research Thesis

Presented in partial fulfillment of the requirements for graduation with research distinction in Psychology in the undergraduate colleges of The Ohio State University

by

Cora Evano

The Ohio State University

June 2013

Project Advisor: Assistant Professor Melissa T. Buelow, Department of Psychology

Abstract

Previous research has shown a positive correlation between working memory and performance on a measure of risky decision making, the Iowa Gambling Task (IGT). However, to date, no one has manipulated the presence of music and increased working memory load during this task. The present study sought to see how these factors influence decision making. In Part One, 90 undergraduate students (44 females, mean age 19.29) were randomly assigned to complete several computerized decision making tasks with classical, rock, or no music playing passively in the background. Results indicated a trend towards those listening to music, regardless of the type of music, were less risky on one of the tasks than those in the non-music condition. In Part Two, 90 undergraduate students (54 females, mean age 18.57) were randomly assigned to one of three working memory load conditions while simultaneously completing the same series of decision making tasks: a) counting a particular word in rock songs; b) counting tempo changes in classical songs; or c) completing working memory tasks. Results indicated that individuals listening to rock music were riskier on only one of the decision making tasks. Implications for this study include the need to reduce distractions and multi-tasking while making difficult decisions in everyday life.

Music is all around us—from music playing over the radio to jingles on television commercials to concerts taking place nearly every day of the week. In addition, many college students choose to study while listening to music—could this have a negative effect on their performance? Individuals go about their daily lives, making frequent decisions, while listening to music on iPods or other music listening devices—could this decrease their decision making abilities? Does listening to music while completing other tasks use up vital working memory resources that in turn impair performance? The present study sought to examine the role of music in decision making. First, frontal lobe structures and their involvement in working memory and decision making will be examined, followed by a review of the results of previous studies of music in cognition.

The Frontal Lobe and Executive Functions

The frontal lobe is located in the front of the cerebral cortex, anterior to the central sulcus (Purves, Augustine, Fitzpatrick, Katz, Lamantia, & McNamara, 2001). Besides involvement in motor functions, one of the primary functions of the frontal lobe is executive functioning. Executive functions can be defined as a set of higher order cognitive processes that include such abilities as decision making, working memory, long-term memory, organization, and planning (Bechara & Martin, 2004; Purves et al., 2001). Results from neuroimaging studies, as well as studies examining individuals with brain injuries, have also lent support that executive functions are linked with frontal lobe functioning. Damage to the frontal lobe can impair prospective memory, which means that individuals will have difficulty gaining new memories as well as keeping and accessing previous memories (McFarland & Glisky, 2009). In addition, individuals with frontal lobe damage can incur memory retrieval deficits that individuals with temporal lobe damage, an area involved in memory consolidation, do not have (McDonald, Bauer, Grande,

Gilmore, & Roper, 2000). Finally, neuroimaging results indicate evidence of age-related changes, as children's' brains show a delay in the activation of the frontoparietal circuit compared to adults (Jolles, Kleibueker, Rombouts, & Cron, 2011). This finding may underlie the positive age-related changes in frontal lobe tasks such as working memory.

Working memory is one of the executive functions linked with the frontal lobe. It can be defined as the process of holding information in memory while also completing a task that requires manipulation of this information (Salhouse & Babcok, 1991). Working memory ability is tied into general intelligence (Conway, Kane, & Engle, 2003), but is also linked with other cognitive abilities such as attention and long-term memory (Wright & Fergadiotis, 2012). Working memory skills have been linked to the prefrontal cortex, as this area of the brain utilizes executive mechanisms to keep and access information required for a task and inhibit other non-useful information (Conway et al., 2003). fMRI studies have shown higher activation in the prefrontal cortex during digit span tasks, which measure working memory skill (Ma, Stenberg, Hansan, Narayana, Kramer, & Moeller, 2011). Individuals with damage to other areas of the brain, including those with aphasia due to left temporal lobe dysfunction, do not have difficulty with working memory (Wright & Fergadiotis, 2012). Being distracted, such as by increasing working memory load, can also in turn cause impairments on other executive function tasks such as the Stroop, a measure of inhibitory control (Lavie & Fockert, 2005).

The limits of working memory have also been investigated. Studies have shown that individuals can typically hold only seven plus or minus two items in working memory at a given time (Saaty & Ozdemir, 2003). Therefore, for one to remember more than this they will engage in techniques that will aid memory such as using mnemonics or chunking (Lyon, 1977). It is possible that completing two tasks simultaneously may deplete working memory resources, as

individuals may not be able to chunk information on both tasks. This could in turn impair performance on each task. In addition, working memory ability is associated with selective attention, updating new information, and later keeping track of that information (Redick, Calvo, Gay, & Engle, 2011), suggesting that decreased working memory capacity could negatively affect memory and decision making that require effortful processing of information.

Working memory is at times referred to as multi-tasking. Multi-tasking can be defined as completing two tasks simultaneously (Clapp, Rubbens, Sabharwal, & Gazzaley, 2011), and has been linked with both frontal lobe functioning (Spataro, Mulligan & Rossi-Arnaud, 2010) and working memory ability (Starcke, Pawlikowski, Wolf, Alstötter-Gleich, & Brand, 2011). Lesions to regions of the frontal lobe associated with various aspects of memory can impair multi-tasking ability (Fletcher & Henson, 2001). Thus, it appears that working memory and multi-tasking utilize the same frontal cortex structures. These executive functions, when taxed, may affect the ability to complete other cognitive tasks such as those required to make a decision.

Decision Making

Decision making refers to the process of evaluating benefits and risks (pros and cons) in order to arrive at some conclusion, and can been seen in children as young as six years old (Figner & Voelki, 2004). Previous research has shown that the frontal cortex, and in particular the prefrontal cortex, is implicated in decision making (Bechara & Martin, 2004). There are two main types of decision making, “cold” and “hot” decision making. When one is using “cold” decision making, they are being rational and evaluating both the risks and benefits of their choices in the context of past experiences (Shafir, Simonson, & Tversky, 1993). When one is using “hot” decision making, they rely instead on affective “gut feelings” (Damasio, 1994).

The most common behavioral measures of decision making used by neuropsychologists are the Iowa Gambling Task (IGT; Bechara, Damasio, Damasio, & Anderson, 1994), the Balloon Analogue Risk (BART; Lejuez et al., 2002), and the Columbia Card Task (CCT; Figner, Mackinlay, Wilkening, & Weber, 2009). The IGT was created in the 1990's to help understand decision making in a laboratory setting (Bechara et al., 1994) among individuals with frontal lobe injuries, particularly in the prefrontal cortex, and damage to the amygdala but were showing normal results in other laboratory tests (Buelow & Suhr, 2009). On the IGT, participants select cards from one of four decks with the goal of maximizing the amount of money by the end of the 100 trials. Some decks they select from will enable them to have more money whereas other decks will make them lose more money. On average, participants receive $50 from each drawing from Decks C or D. They receive $100 on average if they draw from Decks A or B. However, if the participant continues to draw from Deck A or Deck B they will lose $250 per ten selections. If they instead choose from Deck C or Deck D, they will earn $250 per ten selections. This is best summed up by Bechara et al. (1994) who termed Decks A and B "disadvantageous" decks and Decks C and D "advantageous" decks.

The BART assesses participants' risk-taking behaviors (Lejuez et al., 2002). The computerized task was created to imitate a real-world experience and is comprised of 30 trials. Each trial has one balloon, and participants are asked to pump up the balloon to earn money. However, each balloon could pop at any point and the money earned on that balloon would be lost. This tests risk-taking because each click allows the person to gain five cents and the participant can stop clicking at any time in order to gain the money earned on each trial. If the participant is failing at the task they continually pop the balloons—a risky decision because they

did not stop before the balloon popped. Thus, risky participants have a higher average number of pumps on this task.

The CCT is a computerized task that measures risky decision making (Figner et al., 2009). On the CCT, there are 32 cards that display on the screen on each of the 24 trials. At the top of the screen is information about the gain amount per card, the number of loss cards, and the amount to be lost from a loss card. Participants flip over a card and one of two things will happen: the participant will either receive a monetary gain (win card) or they will lose (loss card) and the trial will end. There are two versions of the CCT. In the "cold" version the participant tells the computer how many cards they want to turn over, but will not receive any feedback about those selections. In the "hot version", the participant turns over as many cards as they like until they decide to stop on a given trial. In general, people have age-related changes in their executive functioning that is also seen on the IGT: younger adults make riskier decisions than older adults (Figner et al., 2009).

Although all three tasks have been deemed measures of "hot" decision making, and thus linked to the prefrontal portion of the frontal lobe, the relationship between the tasks is not clear. Do they measure the same aspects of decision making, and could music and working memory load affect performance in different ways? Studies have shown that the IGT and the BART are not related (e.g., Aklin, Lejuez, Zvolensky, Kahler, & Gwadz, 2005); however, it is believed that both test aspects of hot decision making. As the CCT is a new task, no published research has examined how it relates to other decision making tasks. Numerous studies have examined links between the IGT and working memory abilities, with evidence suggesting that there is a positive correlation between working memory ability and decision making (for a review, see Toplak, Soregem Benoit, West, & Stanovish, 2010). However, to date no research has directly

manipulated working memory ability during this decision making task. Using different decision making tasks, participants who completed a secondary working memory task during decision making had worse decision making than those who were not multi-tasking (Starcke et al., 2001; Worthy, Otto, & Maddox, 2012). It is possible that actively listening to music could impair working memory load, in turn affecting performance on hot decision making tasks.

Music and Cognition

Several previous studies have examined how the presence of music, usually presented passively in the background, affects mood and cognition. Neuroimaging studies have shown that music is processed at least partially by the frontal lobe (Spatarp et al., 2010; Potes, Gunduz, Brunner, & Schalk, 2012), meaning it is possible that listening to music while completing another frontal lobe task, such as a working memory or decision making task, may tax working memory resources in turn decreasing performance on that secondary task. Researchers have found that listening to music increases dopamine levels in the brain, resulting in feelings of pleasure (Salimpoor, Benovoy, Larcher, Dagher, & Zatorre, 2011). Furthermore, individuals who are pathological gamblers will show riskier performance on the IGT, but are simultaneously experiencing a "rush" from dopamine being released in the ventral striatum (Linnet, Møller, Peterson, Gjedde, and Doudet, 2011). Since one's IGT performance can be influenced by dopamine levels one can theorize that music, which influences dopamine levels, may also influence IGT performance and possibly performance on other decision making tasks.

In terms of other cognitive abilities, memory performance decreases when music is played passively in the background (Abel, 2009). However, the key component might not be presence of music per se, as music that is more arousing can affect memory and potentially attentional/working memory resources (Judde & Richard, 2010). This leads to the hypothesis that

the type of music played, and whether that music is passively or actively listened to, could affect cognitive abilities. Studies also have shown that when multi-tasking with background noise participants have worse performance (Abel, 2009). Studies have also shown that when the participant is multi-tasking, if music with little variability is played passively in the background then the participant will have better performance than if the background music has high variability (Perkham & Sykora, 2012). Furthermore, when music is played with a metronome in the background, emphasizing the rhythm, it increased participants' ability to learn and retrieve text (Wallace, 1994). Interestingly, participants with prior singing experience did not have increased performance compared to those with no experience in this study (Wallace, 1994).

To date, no studies have directly examined the influence of music specifically on decision making. Previous research has shown that when task effort is low, it could in turn have a negative effect on decision making (Betsch & Glöckner, 2010). Thus, it is possible that the presence of music could be distracting enough to participants to decrease their level of effort, in turn impairing decision making. If listening to music became an active listening task– for example, if participants were told to listen for a particular word in a song–then it may become even more distracting.

The Present Study

To date, several studies have shown correlations between working memory and decision making; however, the relationship between music and decision making has not been examined. In addition, direct manipulation of working memory capacity during decision making has not been studied. The present study seeks to examine these two aims. In the first part of the study, participants will complete decision making tasks while different types of music play passively in the background. In the second part of the study, a separate group of participants will complete a

multi-tasking paradigm in which they will actively listen to music or complete a working memory task while also completing decision making tasks (i.e., dual-tasking).

The hypotheses are as follows. For the first part of the study, it is hypothesized that individuals who listen to rock music will exhibit riskier performance on computerized decision making tasks than individuals who listen to classical or no music. For the second part of the study, it is hypothesized that individuals who complete a working memory task during decision making task (dual task) will exhibit worse decision making performance than individuals who complete a secondary task related to music during decision making.

Methods

Participants

Participants were 180 undergraduate students at The Ohio State University Newark, aged 18 or older, enrolled in General Psychology courses. Interested participants signed up via an online system for either Part One or Part Two of the present study. Part One of the study included 90 undergraduate students (44 females; 70% Caucasian; mean age 19.29 [SD =3.89]). Part Two of the study included an additional 90 undergraduate students (54 females; 77.1% Caucasian, mean age 18.57 [SD = 1.29]).

Measures

Demographic and Background Information Questionnaire. This study–specific questionnaire was created for the present study and includes questions about gender, age, ethnicity, socioeconomic status, and substance use and medical history (Appendix A).

Music History Questionnaire. This study-specific form asked participants to indicate their background with music, including any instruments played and proficiency, music preferences, and previous music education. (Appendix B).

Positive and Negative Affect Schedule (PANAS). The PANAS is a 20-item measure assessing two components of affect: positive and negative (Watson, Clark, & Tellegen, 1988). For the purposes of the present study, the current affect ("right now") version was used (Appendix C). Participants responded to these questions on a 1 (not at all) to 5 (very much) scale. If the participant received a high score on the positive subscale, then the participant was likely experiencing high energy, enthusiasm, and/or alertness. If the participant received a high score on the negative subscale, then the participant was likely to be feeling angry, contempt, disgusted, and/or nervous. Both the positive and negative subscales show high internal consistency (a = .85 - .89), and 8-week test-retest reliability is moderate (r = .45 - .54; Watson et al., 1988).

Beck Depression Inventory-II (BDI-II). The BDI-II is used to assess severity of current depressive symptoms (Beck, Steer, & Brown, 1996). The BDI-II has 21 questions in which the participant has to choose one of the four responses that best describe current symptoms (Beck et al.,1996), with higher scores indicating more severe symptoms. The BDI-II assesses sleep disturbance, fatigue, depressed mood, and anhedonia. Internal consistency (α = .91; Beck et al., 1996) and one-week test-retest reliability (r = .93; Beck et al., 1996) are both high.

Post-Manipulation Music Questionnaire. This study-specific form asked participants about their previous knowledge of the music used in the study manipulation (Appendix D). It also asked what the participant believed the study was designed to investigate and further evaluated current mood and attitudes towards the music used in the study.

Working Memory Subtests from the Wechsler Adult Intelligence Scale-IV (WAIS-IV). The WAIS-IV was created to measure intellectual functioning in adults (Wechsler, 2008). In the present study, only the Digit Span and Letter-Number Sequencing subtests from the Working

Memory Index were used. On Digit Span, participants heard a series of numbers and repeated them back in the same order (forwards), in reverse order (backwards), or in increasing numerical order (sequencing). Difficulty increased after each turn. On Letter-Number Sequencing, the participant was given a sequence of letters and numbers and to repeat back the numbers first, in numerical order, then the letters in alphabetical order. These tasks were used to manipulate working memory load in Part Two of the study.

Word Reading Subset from the Wide Range Achievement Test-IV (WRAT-IV). The Word Reading subtest is a fast and simple test to estimate participants' intelligence levels (Wilkinson & Robertson, 2006). Participants are given a list of 55 words to pronounce in order of increasing difficulty. The participant is scored on the accuracy of their pronunciation, with higher composite scores indicating a higher estimated intelligence level. This test was included to determine if cognitive ability affected decision making performance.

Music Recordings. Several music recordings were used as stimuli in the present study. For those in the classical music condition, they listened to the following selections: *Concerto for 2 Mandolins, Strings, and Continuo in G* (Vivaldi); *Concerto for Lute, 2 Violins, and Continuo in D* (Vivaldi); *Concerto for Violin in E Major* (Vivaldi); *Concerto in F Major for Violin, String Orchestra, and Continuo* (Vivaldi), *Violin Concerto in F Minor* (Vivaldi), and *Violin Concerto in G Minor* (Vivaldi). For those in the rock music condition, they listened to the following selections: *Creeping Death* (Hetfield, 1984); *Fade to Black* (Hetfield, 1984); *Fight Fire with Fire* (Hetfield, 1984); *For Whom the Bell Tolls* (Hetfield, 1984); *Trapped Under Ice* (Hetfield, 1984); *Battery* (Hetfield, 1985); *Damage Inc.* (Hetfield, 1985); *Leper Messiah* (Hetfield, 1985); and *Master of Puppets* (Hetfield, 1985).

Iowa Gambling Task (IGT). The standard computerized IGT was administered (Bechara et al., 1994; Bechara, 2008), and the specifics of the task have been previously discussed. The test-retest reliability of the IGT is not known due to strong practice effects; however, there is significant evidence of real-world clinical relevance of this task (Buelow & Suhr, 2009).

Several studies have shown that not all decks are equal on this task. Although it was originally believed that Decks A and B were both disadvantageous (and C and D both advantageous; Bechara et al., 1994), recent research has shown that decks differ in terms of the frequency of rewards. Decks A and C provide losses on 50% of trials, but Decks B and D provide losses on only 10% of trials (Bechara, 2008). This difference could result in participants selecting more from individual decks, such as from B and D, than from the disadvantageous/advantageous groups of decks. In the present study, the percentage of selections from each individual deck were examined to take this differencing reward frequency into account. In addition, only selections from the last 60 trials were included as the first 40 trials are considered decision making under ambiguity because participants know nothing about the risks and benefits of each deck (Brand, Recknor, Grabenhorst, & Bechara, 2007).

Balloon Analogue Risk Task (BART). The standard computerized BART was also administered. Validity for the BART has been shown through correlations with measures of sensation seeking and impulsivity (Lejuez et al., 2002; Hunt, Hopko, Bare, Lejuez, & Robinson, 2005), and no significant correlations with age, intelligence, depression, and empathy (Lejuez et al., 2002, 2003). In the present study, BART performance was calculated as the average number of pumps per balloon, adjusted for only the unexploded balloons. This is due to not knowing how far participants would have gone on a balloon that exploded. Higher scores indicated higher levels of risky decision making.

Columbia Card Task (CCT). The computerized CCT was also administered (Figner et al., 2009). There are two versions of the CCT. In the cold version, the participant tells the computer how many cards they want to turn over, but does not receive any feedback about those selections. In the hot version, the participant turns over as many cards as they like until they decide to stop on a given trial. The participants in this study all completed the hot condition. The CCT is a relatively new decision making task and reliability and validity data is forthcoming (Figner et al., 2009). In the present study, CCT performance was determined by the average number of cards selected on each trial with higher numbers indicating higher risky decision making.

Procedure

The present study was approved by the Institutional Review Board. Students currently enrolled in General Psychology courses at The Ohio State University Newark had the opportunity to sign-up for either Part One or Part Two of the study. For Part One (passive music), participants provided informed consent and were assigned a random identification number. Participants then completed a series of questionnaires, including the demographic and background information questionnaire, PANAS, music history questionnaire, and the BDI-II. They also completed the word reading subtest from the WRAT-IV to estimate level of cognitive ability. Next, participants were randomly assigned to one of three conditions: no music, classical music (Vivaldi), or rock music (Metallica). Participants completed the three computerized decision making tasks (IGT, BART, CCT), presented in a counterbalanced order, while the assigned music played in the background. After completion of these tasks, participants completed the post-manipulation music questionnaire and then were debriefed and had course credit assigned. Study sessions lasted approximately 60 minutes.

For Part Two (active music) of the study, a separate group of participants provided informed consent and were assigned a random identification number. They completed the WRAT-IV and the same pre-manipulation questionnaires as in Part One. They were then randomly assigned to one of the three experimental conditions: working memory, classical music (Vivaldi), or rock music (Metallica). In order to assess working memory load influences on decision making, participants were asked to complete cognitively-taxing tasks during decision making. Those in the working memory tasks condition completed the Digit Span and Letter-Number Sequencing tasks while simultaneously completing the IGT, BART, and CCT in a random order. Those in the classical music condition were asked to mentally keep track of the number of tempo changes in each song while also completing the decision making tasks. The number of tempo changes ranged from 1 to 12. Finally, those in the rock music condition were asked to mentally keep track of the number of times a particular word occurred in each song while also completing the decision making tasks. The number of lyrics ranged from 1 to 28. The classical and rock music selections remained the same across Part One and Part Two of the present study. Of note, participants in all three conditions were not allowed to write anything down during the working memory or music tasks, thus taxing their working memory capacity while they were also completing decision making tasks. Following completion of the decision making tasks, participants completed the post-manipulation music questionnaire, a second administration of the PANAS, and were debriefed and had course credit assigned. Study sessions lasted approximately 60 minutes.

Data Analysis

First, demographic variables were examined for between-groups differences. In addition, premorbid cognitive ability and history of music lessons were examined for correlations with the

outcome variables. To examine the first hypothesis, that those passively listening to rock music would perform riskier on decision making tasks, a series of one-way ANOVAs were conducted with music group as the between-subjects variables and performance on the decision making tasks as the outcome variables. To examine the second hypothesis, that completing a working memory task during decision making would impair decision making, a second series of one-way ANOVAs were conducted in the same manner.

Results

Testing Hypothesis I

Study variable means and standard deviations are presented in Table 1. For Part One, no differences emerged between groups for age, $F(2,77) = 1.109$, $p = .335$; BDI-II score, $F(2,84) = 0.521$, $p = .596$; gender, χ^2 ($N = 85$) $= 4.338$, $p = .114$; or negative mood at the start of the study, $F(2,86) = 0.498$, $p = .610$. Those in the classical music condition were in a more positive mood than those in the no music condition ($p = .029$). Cognitive ability, history of music lessons, state affect, and demographic variables were not significantly correlated with the decision making tasks ($ps > .064$), and were not included in the remaining analyses. No significant group differences emerged in performance on the BART, $F(2,84) = 1.898$, $p = .156$; or the CCT, $F(2,50) = 1.028$, $p = .365$. In addition, no significant group differences were found in preference for any of the IGT decks ($ps > .601$). Thus, the presence of different types of music playing passively in the background did not affect concurrent risky decision making.

In order to determine if the presence of music, rather than the type of music itself, affected decision making, the two music conditions were combined into one group. Independent-samples *t*-tests indicated that there were no differences in performance on the CCT, $t(51) = 0.273$, $p = .786$, or in any of the IGT deck selections ($ps > .160$). On the BART, there was a trend

towards those who completed the task with music playing in the background ($M = 28.93$, $SD = 11.45$) being less risky than those who completed the task without music playing in the background ($M = 33.68$, $SD = 11.38$), $t(85) = 1.811$, $p = .074$.

Testing Hypothesis 2

Study variable means and standard deviations are presented in Table 2. No differences emerged between groups for age, $F(2,87) = 1.673$, $p = .195$; BDI-II score, $F(2,85) = 0.560$, $p = .574$; gender, χ^2 ($N = 85$) = 2.893, $p = .576$; cognitive ability, $F(2,71) = 1.905$, $p = .156$; negative mood, $F(2,85) = 1.142$, $p = .324$; or positive mood, $F(2,85) = 0.017$, $p = .983$. These variables were not correlated with the CCT (ps > .200); however, age was positively correlated with the BART ($p = .001$) and age, positive and negative affect, and cognitive ability were correlated with IGT deck selections (ps < .039). However, due to the small sample size in this study, these variables were unable to be included as covariates in the following analyses.

No significant group differences emerged in performance on the BART, $F(2,71) = 0.102$, $p = .903$; or the CCT, $F(2,29) = 0.217$, $p = .806$. On the IGT, participants in the Rock condition selected more from Deck A than those in the Classical condition, $F(2,81) = 3.477$, $p = .036$. However, no significant differences emerged for Deck B, $F(2,81) = 0.890$, $p = .415$; Deck C, $F(2,81) = 0.769$, $p = .467$; or Deck D, $F(2,81) = 0.059$, $p = .943$

Discussion

The present studies sought to examine whether the type of music playing in the background, as well as working memory load, affects decision making. This was examined by having participants listen to music either passively or actively. In addition, to date no researchers have directly manipulated working memory ability during risky decision making tasks. In the

second study, working memory load was manipulated by the presence of working memory tasks during decision making.

The first hypothesis tested was that participants passively listening to rock music would be riskier than those listening to classical or no music. The results show that, in fact, it does not matter what type of music is playing in the background while making decisions. The music—rock or classical—did not affect performance on the IGT or CCT. However, music playing passively in the background (regardless of type) resulted in a trend towards less risky performance on the BART than when the task was completed in silence. Working memory ability requires using short-term memory to hold information and use it to complete a task (Salhouse & Babcok, 1991), and has been linked with both attention and long-term memory (Wright & Fergadiotis, 2012). This information would argue in favor of passive background music making decision making more risky, as attention could have been shifted towards the music and away from the task, negatively affecting performance. However, the opposite was found in the present study. Although it makes sense that an effect was seen with the BART but not the IGT or CCT, as the tasks are thought to involve different parts of the brain and types of decision making (Aklin et al., 2005), it is uncertain why the effect was found towards passive music improving decision making. It is possible this occurred because the BART takes less amount of time to complete than the IGT and CCT, as fatigue could have potentially been a factor on the other tasks.

The second hypothesis was that individuals who complete a working memory task during a decision making task will exhibit worse decision making performance than individuals who do not complete this secondary working memory task. This was hypothesized because previous studies have shown that when the participant is not exerting a lot of effort, it in turn decreases

decision making ability (Betsch & Glöckner, 2010). Due to working memory capacity limits (Saaty & Ozdemir, 2003), if a participant has to do more things at the same time, they might not be able to use all their effort on one of the tasks and then decision making might be worse. However, this hypothesis was not supported by the results from the active listening study and runs counter to multiple previous studies that show a positive correlation between working memory ability and decision making on the IGT (Toplak et al., 2010). Instead, it was found that individuals who actively listened to Rock music showed riskier performance on the IGT than individuals who actively listened to Classical music. It appears that the Rock music condition taxed working memory resources, or distracted participants, to a greater degree than completing the dual working memory tasks.

It is interesting that across the two studies, results indicated that the type of music played has a different effect on decision making when it is passively or actively listened to. When either Rock or Classical music plays in the background passively, this improves decision making on the BART; however, Rock music listened to actively instead impairs decision making on the IGT. This could be due to the fact that the IGT and the BART tasks have been shown unrelated (Aklin et al., 2005). Although both tasks assess hot, risky decision making, it has also been shown that the IGT involves more cognitive, cold decision making than the BART (Brand et al., 2007; Guillaume, Jollant, Jaussent, Lawrence, Malafosse, & Courtet, 2009). That active music impaired IGT but not BART performance could mean that actively listening to Rock music impaired this cognitive component on the IGT. However, no true cold decision making tasks were used in the study so this could not be directly assessed. The present results are similar to previous research which showed that when completing a secondary working memory task during

decision making the participants had worse decision making who were not multi-tasking (Starcke et al., 2001; Worthy et al., 2012).

There were several limitations that could have affected results. The present study used a sample of 30 participants per condition, based on an a priori power analysis. However, it is uncertain whether sample size could have affected power in the studies. In addition, there were several correlated demographic variables that could not be included in the Part Two analyses due to the potential increase in Type I error rate and decreased power. Future research should utilize larger sample sizes in order to see if these variables affected performance. Furthermore, although the CCT was included in the both parts of the study, those in the passive listening conditions (Part One) could not always get to this test due to time constraints. Future research should examine music and working memory influences on the CCT, both the cold and hot versions. Additional cold decision making tasks should be examined to see if passive or active music listening and working memory load affects performance. No estimate of working memory ability was made prior to the study manipulations, so there is no way to tell in the present study if participants' level of working memory skill positively or negatively affected their ability to concentrate on the decision making tasks. This study was also limited in the fact that only the Rock music condition had lyrics and no other condition had lyrics, meaning that the Rock music condition differed from the Classical music condition on two variables (rhythm and lyrics) rather than just one. Future research should tease apart the influence of lyrics/words versus music tempo/rhythm on dual task performance.

In conclusion, the present study found when participants actively listen to rock music they make riskier decisions on the IGT, but when participants passively listen to either rock or classical music they make safer decisions on the BART. Future research should investigate

music with and without lyrics at different rhythms, in order to determine if the presence of lyrics or the rhythm itself leads to changes in decisions making. Also, future studies could see how different types of music affect decision making, such as pop music or country music. One could also see how singing along to the songs affect ones decision making abilities. Finally, a future study could be done to see what happens when increasing ones working memory load by having the participants actively listen to music and make hot and cold daily decisions to determine what type of decision making is affected by working memory load. The results of the present study indicate that the relationship between music, working memory load, and decision making is complex and multi-faceted.

References

Abel, S. (2009). Stimulus complexity and dual tasking effects on sustained auditory attention in noise. *Aviation, Space, and Environmental Medicine*, *80*(5), 448-453.

Aklin, W.M., Lejuez, C.W., Zvolensky, M.J., Kahler, C.W., & Gwadz, M. (2005). Evaluation of behavioral measures of risk taking propensity with inner city adolescents. *Behaviour Research and Therapy, 43*, 215-228.

Bechara, A. (2008). *Iowa gambling task professional manual*. Lutz, FL: Psychological Assessment Resources.

Bechara, A., Damasio, A.R., Damasio, H., & Anderson, S.W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition, 50*, 7-15.

Bechara, A., & Martin, E.M. (2004). Impaired decision making related to working memory deficits in individuals with substance addictions. *Neuropsychology, 18*(1), 152-162.

Beck, A.T., Steer, R.A., & Brown, G.K. (1996). *Manual for the beck depression inventory-II*. San Antonio, TX: Psychological Corporation.

Betsch, T., & Glöckner, A. (2010). Intuition in judgment and decision making: Extensive thinking without effort. *Psychological Inquiry*, *21*, 279–294.

Brand, M., Recknor, E.C., Grabenhorst, F., & Bechara, A. (2007). Decisions under ambiguity and decisions under risk: Correlations with executive functions and comparisons of two different gambling tasks with implicit and explicit rules. *Journal of Clinical and Experimental Neuropsychology, 29*, 86-99.

Buelow, M.T., & Suhr, A. (2009). Construct validity of the Iowa gambling task. *Neuropsychology Review, 19,* 102-114.

Clapp, W.C., Rubens, M.T., Sabharwal, J., & Gazzaley, A. (2011). Deficit in switching between functional brain networks underlies the impact of multitasking on working memory in

older adults. *PNAS: Proceedings of The National Academy of Sciences of The United States Of America*, *108*(17), 7212-7217.

Conway, A.A., Kane, M.J., & Engle, R.W. (2003). Working memory capacity and its relation to general intelligence. *Trends In Cognitive Sciences*, *7*(12), 547-552.

Damasio, A.R. (1994). *Descartes' error: Emotion, reason, and the human brain*. New York: Putnam.

Figner, B., Mackinlay, R., Wilkening, F., & Weber, E.(2009). Affective and deliberative processes in risky choice: Age differences in risk taking in the Columbia Card Task, *Journal of Experimental Psychology: Learning, Memory, and Cognition, 35*(3), 709-730.

Figner, B. & Voelki, N. (2004). Risky decision making in a computer card game: An information integration experiment. *Polish Psychological Bulletin, 35*(3)*,* 135-139.

Fletcher, P.C., & Henson, R.N.A. (2001). Frontal lobes and human memory insights from functional neuroimaging. *Brain,* 124, 849-881.

Guillaume, S., Jollant, F., Jaussent, I., Lawrence, N., Malafosse, A., & Courtet, P. (2009). Somatic markers and explicit knowledge are both involved in decision-making. *Neuropsychologia, 47*, 2120-2124.

Hetfield, J. (1984). Creeping death (Recorded by Metallica). On *Ride the Lightning* [CD]. Copenhagen, Denmark: Megaforce Records.

Hetfield, J. (1984). Fade to black (Recorded by Metallica). On *Ride the Lightning* [CD]. Copenhagen, Denmark: Megaforce Records.

Hetfield, J. (1984). Fight fire with fire (Recorded by Metallica). On *Ride the Lightning* [CD]. Copenhagen, Denmark: Megaforce Records.

Hetfield, J. (1984). For whom the bell tolls (Recorded by Metallica). On *Ride the Lightning* [CD]. Copenhagen, Denmark: Megaforce Records.

Hetfield, J. (1984). Tapped under ice (Recorded by Metallica). On *Ride the Lightning* [CD]. Copenhagen, Denmark: Megaforce Records.

Hetfield, J. (1985). Battery (Recorded by Metallica). On *Master of Puppets* [CD]. Copenhagen, Denmark: Asylum Records.

Hetfield, J. (1985). Damage inc. (Recorded by Metallica). On *Master of Puppets* [CD]. Copenhagen, Denmark: Asylum Records.

Hetfield, J. (1985). Leper messiah (Recorded by Metallica). On *Master of Puppets* [CD]. Copenhagen, Denmark: Asylum Records.

Hetfield, J. (1985). Master of puppets (Recorded by Metallica). On *Master of Puppets* [CD]. Copenhagen, Denmark: Asylum Records.

Hunt, M.K., Hopko, D.R., Bare, R., Lejuez, C.W., & Robinson, E.V. (2005). Construct validity of the balloon analog risk task (BART): Associations with psychopathy and impulsivity. *Assessment, 12*, 416-428.

Jolles, D., Kleibeuker, S., Rombouts, S., & Crone, E. (2011). Developmental differences in prefrontal activation during working memory maintenance and manipulation for different memory loads. *Developmental Science, 14*(4), 713-724.

Judde, S., & Rickhard, N. (2010) The effect of post-learning presentation of music on long-term word-list retention. *Neurobiology of Learning and Memory*, *94*(1), 13-20.

Lavie, N., & Fockert, J. (2005). The role of working memory in attentional capture. *Psychonomic Bulletin and Review, 12*(4), 669-674.

Lejuez, C.W., Aklin, W.M., Jones, H.A., Richards, J.B., Strong, D.R., Kahler, C.W., & Read, J.P. (2003a). The balloon analogue risk task (BART) differentiates smokers and nonsmokers. *Experimental and Clinical Psychopharmacology, 11*, 26-33.

Lejuez, C.W., Read, J.P., Kahler, C.W., Richards, J.B., Ramsey, S.E., Stuart, G.L., et al. (2002). Evaluation of a behavioral measure of risk taking: The balloon analogue risk task (BART). *Journal of Experimental Psychology: Applied, 8,* 75-84.

Linnet, J., Møller, A., Peterson, E., Gjedde, A., & Doudet, D. (2011). Dopamine release in ventral striatum during Iowa Gambling Task performance is associated with increased excitement levels in pathological gambling. *Addiction, 106*(2), 383-390.

Lyon, D. (1977). Individual differences in immediate serial recall: A matter of mnemonics? *Cognitive Psychology, 9(4)*, 403-411.

Ma, L., Steinberg, J.L., Hasan, K.M., Narayana, P.A., Kramer, L.A., & Moeller, F. (2012). Working memory load modulation of parieto-frontal connections: Evidence from dynamic causal modeling. *Human Brain Mapping*, *33*(8), 1850-1867.

McDonald, C.R., Bauer, R.M., Grande, L., Gilmore, R., Roper, S. (2001). The role of the frontal lobes in memory: Evidence from unilateral frontal resections for relief of intractable epilepsy. *Archives of Clinical Neuropsychology, 16*, 571–85.

McFarland, C.P., & Glisky, E. (2009). Frontal lobe involvement in a task of time-based prospective memory. *Neuropsychologia, 47*, 1660-1669.

Perkham, N., & Sykora, M. (2012). Disliked music can be better for performance than liked music. *Applied Cognitive Psychology, 26*, 550-555.

Potes, C., Gunduz, A., Brunner, P., & Schalk, G. (2012). Dynamics of electrocorticographic (ECoG) activity in human temporal and frontal cortical areas during music listening. *Neuroimage*, *61*(4), 841-848.

Purves, D., Augustine, G.J., Fitzpatrick, D.F., Katz, L.C., Lamantia, A.S., & McNamara, J.D. (2001). *Neuroscience.* Sunderland, MA: Sinauer Associates, Inc.

Redick, T., Calvo, A., Gay, C., & Engle, R. (2011). Working memory capacity and go/no-go task performance: selective effects of updating, maintenance, and inhibition. *Journal of Experimental Psychology*, *37*(2), 308-332.

Saaty, T.L., & Ozdemir, M.S. (2003). Why the magic number seven plus or minus two. *Mathematical and Computer Modeling, 38*(3-4), 233-2444.

Salimpoor, V., Benovoy, M., Larcher, K., Dagher, A., & Zatoree, R. (2011). Anatomically distinct dopamine release during anticipation and experience of peak emotion to music. *Nature Neuroscience, 14*(2), 257-264.

Salthouse, T.A., & Babcock, R.L. (1991). Decomposing adult age differences in working memory. *Developmental Psychology, 27*(3), 763-776.

Shafir, E., Simonson, I., & Tversky, A. (1993). Reason-based choice. *Cognition, 49*, 11-36.

Spataro, P., Mulligan, N.W., Longobardi, E., & Rossi-Arnaud, C. (2012). Effects of age-of-acquisition in the word-fragment completion task: Evidence for an orthographic locus in implicit memory. *Experimental Psychology, 59*, 22-29.

Starcke, K., Pawlikowski, M., Wolf, O.T., Altstötter-Gleich, C., & Brand, M. (2011). Decision-making under risk conditions is susceptible to interference by secondary executive task. *Cognitive Processes,* 12, 177-182.

Toplak, M.E., Sorege, G.B., Benoit, A., West, R.F., & Stanovich, K.E. (2010). Decision-making and cognitive abilities: A review of associations between Iowa gambling task performance, executive functions, and intelligence. *Clinical Psychology Review, 30*, 562-581.

Vivaldi, A. Concerto for 2 Mandolins, Strings, and Continuo in G, R 532: I Allegro [Recorded by New London Consort]. On *Vivaldi: 14 Concertos* [CD]. (1997)

Vivaldi, A. Concerto for Lute, 2 Violins, and Continuo in D, RV 93: 1 Allegra Giusto [Recorded by New London Consort]. On *Vivaldi: 14 Concertos* [CD]. (1997)

Vivaldi, A. Concerto for Violin in E Major, RV 269, Op 8, No 1, Spring: 1 Allegro [Recorded by St. Petersburg Radio and TV Symphony Orchestra]. On *The 50 Most Essential Pieces of Classical Music* [CD]. (2008)

Vivaldi, A. Concerto in F Major for Violin, String Orchestra, and Continuo, Op 8, No 3, RV 293, Autumn: 1 Allegro [Recorded by Joshua Bell]. On *Vivaldi: The Four Seasons* [CD]. (2008)

Vivaldi, A. Violin Concerto in F Minor, RV 297, Winter: III Allegro [Recorded by Janine Jansen]. On *Vivaldi: The Four Seasons* [CD]. (2005)

Vivaldi, A. Violin Concerto in G Minor, RV 315, Summer: 1 Allegro Non Molto [Recorded by Janine Jansen]. On *Vivaldi: The Four Seasons* [CD]. (2005)

Wallace, W. (1994). Memory for music: Effects of melody on recall of text. *Journal of Experimental Psychology, 20*, 1471-1485.

Watson, D., Clark, L.A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*, 1063-1070.

Wechsler, D. (2008). *Wechsler adult intelligence scale-fourth edition (WAIS-IV)*. San Antonio, TX: Pearson.

Worthy, D.A., Otto, A.R., & Maddox, W.T. (2012). Working-memory load and temporal myopia in dynamic decision making. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 28*(6), 1640-1658.

Wilkinson, G.S., & Robertson, G.J. (2006). *Wide range achievement test 4 (WRAT4)*. Lutz, FL: PAR, Inc.

Wright, H., & Fergadiotis, G. (2012). Conceptualising and measuring working memory and its relationship to aphasia. *Aphasiology*, *26*(3-4), 258-278.

Table 1. Part One Study Variables as *Mean (Standard Deviation)*.

Variable	No Music *n* = 30	Classical Music *n* = 30	Rock Music *n* = 30
Music Background	n/a	19 Yes	18 Yes
Gender	15 F	11 F	18 F
Age	20.16 (5.80)	18.57 (1.60)	19.22 (3.32)
WRAT-IV	n/a	102.39 (9.80)	95.70 (9.51)
PANAS-P	2.77 (0.78)*	3.26 (0.62)	3.12 (0.75)
PANAS-N	1.49 (0.55)	1.47 (0.54)	1.61 (0.63)
BDI-II	10.18 (8.65)	8.87 (7.84)	11.07 (8.56)
IGT			
Deck A	15.49 (7.84)	15.60 (8.79)	16.31 (10.52)
Deck B	24.57 (13.36)	28.51 (14.76)	30.30 (15.75)
Deck C	25.06 (17.47)	21.90 (10.40)	23.75 (15.13)
Deck D	34.88 (22.07)	33.99 (19.81)	29.58 (20.77)
BART	45.11 (61.79)	27.86 (11.15)	30.04 (11.85)
CCT	10.15 (2.93)	10.61 (2.54)	9.11 (1.77)

*$p < .05$

Note: WRAT-IV = Wide Range Achievement Test, Word Reading Standard Score; PANAS-P = Positive and Negative Affect Schedule- Positive; PANAS-N = Positive and Negative Affect Schedule- Negative; BDI-II = Beck Depression Inventory-II; IGT = Iowa Gambling Task, percentage of individual deck selections; BART = Balloon Analogue Risk Task, average

adjusted number of pumps per balloon; CCT = Columbia Card Task, average number of selections.

Table 2. Part Two Study Variables as *Mean (Standard Deviation)*.

Variable	Working Memory *n* = 30	Classical Music *n* = 30	Rock Music *n* = 30
Music Background	16 Yes	16 Yes	16 Yes
Gender	19 F	16 F	19 F
Age	18.33(0.64)	18.93 (1.98)	18.39(0.50)
WRAT-IV	92.67(9.85)	94.44 (1.22)	98.35(9.24)
PANAS-P 1	2.96 (0.88)	3.00 (0.63)	2.97 (0.82)
PANAS-N 1	1.55 (0.53)	1.63 (0.58)	1.43 (0.37)
PANAS-P 2	2.67 (0.97)	2.68 (0.84)	2.50 (0.97)
PANAS-N 2	1.60 (0.61)	1.51 (0.43)	1.40 (0.41)
BDI-II	10.45(8.76)	8.57(7.75)	8.72(6.15)
IGT			
Deck A	16.78 (9.07)	14.49 (7.48)*	20.06 (6.58)
Deck B	27.00 (15.11)	31.22 (13.17)	27.50 (8.87)
Deck C	25.56 (11.37)	22.76 (10.68)	22.68 (7.70)
Deck D	30.61 (22.26)	31.54 (16.47)	29.76 (17.48)
BART	27.87 (10.48)	26.49 (13.95)	26.47 (12.61)
CCT	10.53(2.53)	9.75(2.46)	10.18(2.86)

*$p < .05$.

Note: WRAT-IV = Wide Range Achievement Test, Word Reading Standard Score; PANAS-P = Positive and Negative Affect Schedule- Positive; PANAS-N = Positive and Negative Affect Schedule- Negative; BDI-II = Beck Depression Inventory-II; IGT = Iowa Gambling Task,

percentage of individual deck selections; BART = Balloon Analogue Risk Task, average adjusted number of pumps per balloon; CCT = Columbia Card Task, average number of selections.

Appendix A

Demographic and Background Information

Number: _____

Please complete the following questions. You can leave blank any questions you feel uncomfortable answering.

1. Gender: Male _____ Female _____

2. Age: _____

3. Educational Level:

First year college	_____	Fourth year college	_____
Second year college	_____	Fifth year college	_____
Third year college	_____	Other: _____	

4. What is your approximate GPA?

Below 1.00	_____	2.50 – 2.99	_____
1.00 – 1.49	_____	3.00 – 3.49	_____
1.50 – 1.99	_____	3.50 or higher	_____
2.00 – 2.49	_____		

5. Which best describes your ethnic background (check as many as needed):

Caucasian	_____	Black/African-American	_____
Hispanic	_____	American Indian or Alaska Native	_____
Asian or Pacific Islander	_____	Other: _____	

6. What is your parents' current marital status?

Married	_____	Divorced	_____
Separated	_____	Cohabitating	_____
Widowed	_____	Other: _____	

7. What was your family's average yearly income when you were in high school?

$15,000 or less	_____	$65,001 - $80,000	_____
$15,001 – $25,000	_____	$80,001 - $95,000	_____
$25,001 - $35,000	_____	$95,001 - $110,000	_____
$35,001 - $50,000	_____	$110,001 - $125,000	_____
$50,001 - $65,000	_____	Over $125,000	_____

8. If you currently live with your family of origin (i.e., parents, grandparents), what was your family's approximate income last year?

$15,000 or less	_____	$65,001 - $80,000	_____
$15,001 – $25,000	_____	$80,001 - $95,000	_____
$25,001 - $35,000	_____	$95,001 - $110,000	_____
$35,001 - $50,000	_____	$110,001 - $125,000	_____
$50,001 - $65,000	_____	Over $125,000	_____

9. If you live independently or with your own family, what was your approximate income last year?

$15,000 or less	_____	$65,001 - $80,000	_____
$15,001 – $25,000	_____	$80,001 - $95,000	_____
$25,001 - $35,000	_____	$95,001 - $110,000	_____
$35,001 - $50,000	_____	$110,001 - $125,000	_____
$50,001 - $65,000	_____	Over $125,000	_____

10. What is the highest level of education completed by your mother?

Less than 12th grade	_____	Some graduate school	_____
High School graduate	_____	Master's Degree	_____
Some college	_____	Ph.D., JD, MD	_____
College graduate	_____	Other: _____	

11. What is the highest level of education completed by your father?

Less than 12th grade	_____	Some graduate school	_____
High School graduate	_____	Master's Degree	_____
Some college	_____	Ph.D., JD, MD	_____
College graduate	_____	Other: _____	

12. Have you ever received a diagnosis of Attention-Deficit/Hyperactivity Disorder (ADHD) or Attention-Deficit Disorder (ADD)?

Yes _____
No _____
If Yes, subtype: Inattentive _____
Hyperactive _____
Combined _____

13. How old were you when you were diagnosed with ADHD or ADD? _____

14. Who diagnosed you with ADHD or ADD?

Physician (MD) _____
Psychologist (PhD) _____
Psychiatrist (MD) _____
School Counselor or Psychologist _____
Other (please specify): _____

15. What medications have you tried to treat ADHD/ADD (mark all that apply):

Adderall	_____	Ritalin	_____
Adderall-XR	_____	Ritalin-SR	_____
Concerta	_____	Ritalin-LA	_____
Dexedrine	_____	Strattera	_____
Dexedrine-XR	_____	Vyvanse	_____
Focalin	_____	Other (please specify):	
Focalin-XR	_____	_____	
		_____	
		_____	

16. What current medications are you taking to treat ADHD/ADD (mark all that apply):

Adderall	_____	Ritalin	_____
Adderall-XR	_____	Ritalin-SR	_____
Concerta	_____	Ritalin-LA	_____
Dexedrine	_____	Strattera	_____
Dexedrine-XR	_____	Vyvanse	_____
Focalin	_____	Other (please specify):	
Focalin-XR	_____	_____	
		_____	
		_____	

17. If you are currently receiving medication to treat ADHD/ADD, when did you last take your medication? _____

18. Have you ever received a diagnosis of a Learning Disorder (LD), such as a Reading Disorder, Writing Disorder, or Math Disorder?

Yes _____
No _____

19. How old were you when you were diagnosed with an LD? _____

20. Have you ever received a psychiatric diagnosis, such as depression, anxiety, Bipolar Disorder, or Schizophrenia?

Yes _____
No _____

21. How old were you when you received a psychiatric diagnosis? _____

22. Are you currently, or have you in the past, received treatment for a psychiatric disorder?

Yes, currently _____
Yes, in the past _____
Yes, currently and in the past _____
No, never _____

23. Are you currently experiencing any sleep-related difficulties, such as:

Difficulty falling asleep _____
Difficulty staying asleep _____
Waking too early in the morning_____
Stopping breathing during sleep _____
Snoring _____

24. How many days per week, on average, do you experience sleep difficulty? _____

25. Have you ever been diagnosed with a Traumatic Brain Injury (TBI) or a head injury?

Yes _____
No _____

26. How many TBIs or head injuries have you experienced in your lifetime? _____

27. Have you ever lost consciousness after hitting your head?
    - Yes, only for a few seconds _____
    - Yes, for less than 10 minutes _____
    - Yes, for less than 1 hour _____
    - Yes, for over 1 hour _____
    - No _____

28. Were you ever hospitalized following a head injury?
    - Yes _____
    - No _____

29. Have you ever undergone brain surgery following a head injury?
    - Yes _____
    - No _____

30. Are you currently experiencing any cognitive (thinking) difficulties related to a head injury?
    - Yes _____
        - How long ago was the injury? _____
    - No _____

31. Have you ever experienced a concussion, such as while playing sports?
    - Yes _____
    - No _____

32. How many concussions have you experienced in your lifetime? _____

33. Do you drink caffeinated beverages, such as caffeinated soft drinks, coffee, and tea?
    - Yes _____
    - No _____

34. Do you consider yourself a regular caffeine drinker?
    - Yes _____
    - No _____

35. During the past 30 days, on how many did you drink a caffeinated beverage? _____

36. How many caffeinated beverages do you drink per day, on average? _____

37. Do you consider yourself a regular or social cigarette smoker?
    - Social _____
    - Regular _____
    - Neither _____

38. How old were you when you smoked a whole cigarette for the first time? _____

39. During the past 30 days, on how many did you smoke cigarettes? _____

40. How many cigarettes do you smoke per day, on average? _____

41. Have you ever tried to quit smoking cigarettes?
    - Yes, and I do not smoke cigarettes now _____
    - Yes, but I returned to smoking cigarettes _____
        - Number of quit attempts: _____
    - No, I have never tried to quit smoking cigarettes _____
    - No, I have never smoked cigarettes _____

42. During the past 30 days, on how many days did you use chewing tobacco or snuff? _____

43. How old were you when you first starting using chewing tobacco? _____

44. Have you ever tried alcohol?
    - Yes _____
    - No _____

45. How old were you when you had your first drink of alcohol, other than a few sips? _____

46. Do you currently drink alcohol?
    - Yes _____
    - No _____

47. Do you consider yourself a regular or social user of alcohol?
    - Social _____
    - Regular _____
    - Neither _____

48. During the past 30 days, on how many days did you have at least one drink of alcohol? _____

49. During the past 30 days, on how many days did you have 5 or more drinks of alcohol in a row (i.e., within a couple of hours)? _____

50. Have you ever tried to quit drinking alcohol?
    - Yes, and I do not drink alcohol now _____
    - Yes, but I returned to drinking alcohol _____
        - Number of quit attempts: _____
    - No, I have never tried to quit drinking alcohol _____
    - No, I have never drank alcohol regularly _____

51. Have you ever tried marijuana?
    - Yes _____
    - No _____

52. How old were you when you first tried marijuana? _____

53. Do you consider yourself a regular or social user of marijuana?
    Social _____
    Regular _____
    Neither _____

54. During the past 30 days, on how many days did you use marijuana? _____

55. When you used marijuana in the past 30 days, how much would you use per day? _____

56. Have you ever tried any form of cocaine, including powder, crack, or freebase?
    Yes _____
    No _____

57. How old were you when you first tried any form of cocaine? _____

58. Do you consider yourself a regular or social user of cocaine?
    Social _____
    Regular _____
    Neither _____

59. During the past 30 days, how many times did you use any form of cocaine? _____

60. Do you currently use pain medications (such as codeine, Percocet, Oxycontin, morphine, etc.) without a doctor's prescription, OR do you take more of these medications than is prescribed?
    Yes _____
    No _____

61. During the past 30 days, on how many days did you use pain medications not following a doctor's prescription? _____

62. How many times in the past 30 days did you use inhalants (sniffing glue, breathing contents of aerosol cans, inhaling paints/sprays)? _____

63. How many times in the past 30 days did you use steroids without a doctor's prescription? _____

64. How many times in the past 30 days did you use other illegal substances, such as LSD, PCP, ecstasy, mushrooms, speed, ice, or heroin? _____

65. How many times in the past 30 days did you mix alcohol with other substances? _____

Appendix B

Music Background Questionnaire

1. Have you ever taken music lessons, either individually or in a group?

_____ Yes _____ No

****If NO, please skip to Question #4.**

2. What type of instrument(s) were you instructed on, and when did you receive this training?

Instrument	Start	End
1.		
2.		
3.		
4.		
5.		

3. For each instrument from Question 2, please indicate how you learned to play that instrument from the following choices:

By ear, Music class, Private lessons, Group lessons, From a parent/friend, Online

Instrument 1:

Instrument 2:

Instrument 3:

Instrument 4:

Instrument 5:

4. What type of instrument(s) do you currently play?

5. If you currently play an instrument, how often (per week) do you play?

6. How long have you played the instrument(s) indicated in Question 3?

_____ Less than 6 months

_____ 7 months to 2 years

_____ 2 years to 5 years

_____ 5 years to 10 years

_____ Over 10 years

7. For the instrument from Question 3, please indicate how you learned to play that instrument from the following choices:

By ear, Music class, Private lessons, Group lessons, From a parent/friend, Online

8. Have you ever received vocal lessons?

_____ Yes _____ No

****If NO, please skip to Question #11**

9. When did you receive vocal training?

Start End

10. If you currently are in vocal training, how often (per week) do you practice?

11. What is your background in music theory?

_____ No training in music theory
_____ Basic/elementary training in music theory
_____ Moderate/intermediate training in music theory
_____ Advanced training in music theory

12. What is your background in music composition?

_____ No training in music composition
_____ Basic/elementary training in music composition
_____ Moderate/intermediate training in music composition
_____ Advanced training in music composition

13. If you were asked to compose a piece of music, could you (mark all that apply):

_____ Create the staff
_____ Indicate the measure
_____ Write down a few notes
_____ Write a complete song
_____ Write variations on the song in different keys
_____ Write the complete song with variations in tempo and rhythm

14. How often do you listen to music (i.e., radio, satellite radio, internet streaming, iPod/MP3 player, iTunes, etc.)?

_____ Never
_____ Rarely (Less than one day per week)
_____ Sometimes (2-3 days per week)
_____ Most of the time (4-5 days per week)
_____ Often (6-7 days per week)

15. What type of music do you typically listen to. Please rank the following options from 1 (most often listened to) to 17 (least often listened to):

_____ Alternative
_____ Blues
_____ Classical
_____ Country
_____ Electronic/Techno
_____ Folk
_____ Hip Hop
_____ Jazz
_____ Latin
_____ Musical Theater
_____ Pop
_____ R&B
_____ Rap
_____ Reggae
_____ Religious
_____ Rock
_____ World
_____ Other (please indicate): _____

16. How do you typically listen to music? Check all that apply.

_____ Dance to music
_____ Listen to music while exercising
_____ Listen to before a sporting event
_____ Listen to while studying
_____ Listen to while driving
_____ Listen to while completing chores/household tasks
_____ Listen to before going to sleep
_____ Other (please indicate): _____

17. When you listen to music, do you typically focus on:

_____ The lyrics
_____ The music/beat/rhythm
_____ Both the lyrics and the music/beat/rhythm

18. What are you five favorite bands/musicians:

1:
2:
3:
4:
5:

19. How familiar are you with the lyrics to the songs from your favorite bands/musicians listed in Question 18?

Band/Musician #1: _____

_____ Know none of the lyrics to the songs
_____ Know some of the lyrics to the songs
_____ Know most of the lyrics to the songs
_____ Know all of the lyrics to the songs

Band/Musician #2: _____

_____ Know none of the lyrics to the songs
_____ Know some of the lyrics to the songs
_____ Know most of the lyrics to the songs
_____ Know all of the lyrics to the songs

Band/Musician #3: _____

_____ Know none of the lyrics to the songs
_____ Know some of the lyrics to the songs
_____ Know most of the lyrics to the songs
_____ Know all of the lyrics to the songs

Band/Musician #4: _____

_____ Know none of the lyrics to the songs
_____ Know some of the lyrics to the songs
_____ Know most of the lyrics to the songs
_____ Know all of the lyrics to the songs

Band/Musician #5: _____

_____ Know none of the lyrics to the songs
_____ Know some of the lyrics to the songs
_____ Know most of the lyrics to the songs
_____ Know all of the lyrics to the songs

20. Do you have plans to pursue music in the future, such as (check all that apply):

_____ Start a band
_____ Join a band
_____ Participate in musical theater
_____ Start music lessons
_____ Continue music lessons
_____ Perform for the public
_____ Perform for friends
_____ Major in music

Appendix C

PANAS

Directions: This scale consists of a number of words that describe different feelings and emotions. Read each item and then circle the appropriate answer next to the word. Indicate to what extent you feel this way **right now**.

	Very Slightly	A Little	Moderately	Quite a Bit	Extremely
1. Interested	1	2	3	4	5
2. Distressed	1	2	3	4	5
3. Excited	1	2	3	4	5
4. Upset	1	2	3	4	5
5. Strong	1	2	3	4	5
6. Guilty	1	2	3	4	5
7. Scared	1	2	3	4	5
8. Hostile	1	2	3	4	5
9. Enthusiastic	1	2	3	4	5
10. Proud	1	2	3	4	5
11. Irritable	1	2	3	4	5
12. Alert	1	2	3	4	5
13. Ashamed	1	2	3	4	5
14. Inspired	1	2	3	4	5
15. Nervous	1	2	3	4	5
16. Determined	1	2	3	4	5
17. Attentive	1	2	3	4	5
18. Jittery	1	2	3	4	5
19. Active	1	2	3	4	5
20. Afraid	1	2	3	4	5

Appendix D

End of Study Questionnaire (Lyrics)

1. Have you heard any of the songs played during the experiment before?

_____ Yes _____ No

2. If you answered YES to Question 1, please answer the following: how knowledgeable were you with the lyrics of the songs played during the experiment?

_____ Knew none of the lyrics to the songs
_____ Knew some of the lyrics to the songs
_____ Knew most of the lyrics to the songs
_____ Knew all of the lyrics to the songs

3. How would you describe your emotional experience while listening to the songs?

_____

4. Please rate your agreement/disagreement with the following statements: The songs made me feel:

	Disagree				Agree
Annoyed	1	2	3	4	5
Angry	1	2	3	4	5
Anxious	1	2	3	4	5
Depressed	1	2	3	4	5
Excited	1	2	3	4	5
Energized	1	2	3	4	5
Sad	1	2	3	4	5
Tired	1	2	3	4	5
Uninterested	1	2	3	4	5
Upset	1	2	3	4	5

5. How interested were you in the music/lyrics you listened to:

_____ Not at all
_____ Somewhat
_____ Moderately
_____ Severely

6. How distracted were you by the music and/or lyrics:

_____ Not at all
_____ Somewhat
_____ Moderately
_____ Severely

7. What was the purpose of this experiment, in your own words?

End of Study Questionnaire (Instrumental)

1. Have you heard any of the songs played during the experiment before?

_____ Yes _____ No

2. If you answered YES to Question 1, please answer the following: how knowledgeable were you with the songs played during the experiment?

_____ Knew none of the songs
_____ Knew some of the songs
_____ Knew most of the songs
_____ Knew all of the songs

3. How would you describe your emotional experience while listening to the songs?

_____

4. Please rate your agreement/disagreement with the following statements: The songs made me feel:

	Disagree				Agree
Annoyed	1	2	3	4	5
Angry	1	2	3	4	5
Anxious	1	2	3	4	5
Depressed	1	2	3	4	5
Excited	1	2	3	4	5
Energized	1	2	3	4	5
Sad	1	2	3	4	5
Tired	1	2	3	4	5
Uninterested	1	2	3	4	5
Upset	1	2	3	4	5

5. How interested were you in the music you listened to:

_____ Not at all
_____ Somewhat
_____ Moderately
_____ Severely

6. How distracted were you by the music you listened to:

_____ Not at all
_____ Somewhat
_____ Moderately
_____ Severely

7. What was the purpose of this experiment, in your own words?

End of Study Questionnaire (Working Memory Tasks)

1. Please rate your agreement/disagreement with the following statements: The mental tasks made me feel:

	Disagree				Agree
Annoyed	1	2	3	4	5
Angry	1	2	3	4	5
Anxious	1	2	3	4	5
Depressed	1	2	3	4	5
Excited	1	2	3	4	5
Energized	1	2	3	4	5
Sad	1	2	3	4	5
Tired	1	2	3	4	5
Uninterested	1	2	3	4	5
Upset	1	2	3	4	5

2. How interested were you in the mental tasks you just completed:

_____ Not at all
_____ Somewhat
_____ Moderately
_____ Severely

3. What was the purpose of this experiment, in your own words?